

# **ELECTRIC MOBILITY IN PORTUGAL - THE BEGINNING**

**J.F.G. Mendes & P. Ribeiro**

## **ABSTRACT**

This paper aims to address the main questions related with electric mobility in Portugal. For this, the four principal strategic areas of the electric mobility program in Portugal will be presented, such as the business model, infrastructure, incentives and communication. On the other hand, the current legislation will be succinctly described, as well as the priorities defined in the Program for Electric Mobility. The different phases of implementation of this Program will be identified, with particular emphasis to the measures and incentives in the pilot-phase to promote the use of the electric vehicle. Lastly, the adopted Model for Electric Mobility will be presented in terms of the main components of the model, value chain, actors, charging network and operation of the pilot-phase.

## **1 INTRODUCTION**

The mobility or more specifically the transportation system can be considered the most visible aspect of the functional operation of cities. The high motorization rates related with a strong preference for the individual motorized vehicle instead of the use of public transports has led to the congestion of the main arteries of the city road network, as well as on the massive emission of noise and other types of pollutants, in which the greenhouse gases are included. The associated high costs of time, fuel and the degradation of people's health were studied and quantified by several researchers; however, this recognition has had a limited effect in the expected changes in the mobility patterns of cities. Nevertheless, a deeper conscience of this issue are being induced by questions related with energy consumption and environmental aspects associated with the most recent technological developments.

Among other solutions currently being applied to minimize the impacts of the actual patterns of urban mobility, this paper will address the promotion of electric mobility as an alternative to conventional vehicles with internal combustion engines, which dominate the current traffic scenario of cities.

An electric vehicle does not generate local emissions, which means that with its generalization it would be possible to obtain zero-emissions urban areas, where vehicles, pedestrians and bicyclists could cohabit in a silent environment with a high level of air quality.

Electric mobility uses vehicles with electric engines that are powered by batteries. With the technological improvement of the batteries and the increase in vehicle production, it is expected that the prices of electric cars will reduce and become more competitive. It is estimated that by 2020 around 10 per cent of motorized vehicles will be electric. According to this new paradigm in urban mobility, Portugal developed a national project for electric mobility, named Mobi.E that contemplates a national public network of charging points for electric vehicles.

This paper aims to address the main questions related with electric mobility in Portugal. For this, the four principal strategic areas of the electric mobility program in Portugal will be presented, such as the business model, infrastructure, incentives and communication. On the other hand, the current legislation will be succinctly described, as well as the priorities defined in the Program for Electric Mobility. The different phases of implementation of this Program will be identified, with particular emphasis to the measures and incentives in the pilot-phase to promote the use of the electric vehicle. Lastly, the adopted Model for Electric Mobility will be presented in terms of the main components of the model, value chain, actors, charging network and operation of the pilot-phase.

## **2 ELECTRIC MOBILITY IN PORTUGAL**

Portugal intends to position itself as a pioneer in the adoption of new environmentally sustainable mobility models, capable of optimizing the rational use of electricity by taking advantage of its generation from renewable sources, while integrated with the rate of operation and development of cities.

The adopted strategy rests upon four key areas: business model, infrastructure, incentives and communication, electric vehicles.

Regarding the business model, the aim resides on the definition and integration of several layers of electric mobility, which correspond to different actors at various levels, each adding a specific value. The model known as Mobi.E is based on an innovative information system enabling the interaction of power suppliers, operators and users of the charging areas of electric vehicles, in addition to the managing entity of the entire system.

In terms of the infrastructure, a comprehensive network of charging areas is intended to be created nationwide. The option was the immediate launch of a pilot network in 25 municipalities, which will be completed by 2015 and will enable to test and validate the solutions for electric mobility, creating a dynamic experimenting laboratory for solutions on a national level.

With regard to the incentives and communication, the aim is to create conditions to attract users to electric mobility, particularly through a package of differentiated incentives over other forms of mobility, and also through a communication strategy centred on the benefits to the users. Both the incentives and the communication plans will have national and local expression.

Finally, it is intended to stimulate the market for electric vehicles and promote the electrification of public vehicle fleets. This key area is mainly national.

It is clear that the strategy is achieving a space for which the municipalities are important contributors, so the 25 municipalities that comprise the network pilot undertook the preparation of Municipal plans for Electric Mobility (MPEM), whose implementation horizon is between 2010 and 2015.

In the present context, the Municipal Plans for Electric Mobility are understood as a document that frames and programmes the promotion, encouragement and implementation actions for electric mobility in the city, consistent with national guidelines and respect of local specificities, with the following contents: Overview; Charging network; Incentive measures; Communication plan; Network implementation plan; Monitoring plan.

The framework for the establishment of the MPEM was characterized by a marked diversity of realities, resulting from a universe of 25 municipalities of heterogeneous nature and size. In addition, the period of time available for the development of this work was very short. On the other hand, it was important to ensure consistency and coherence of the national network, which implied a concern for homogeneity in the methodological framework to be adopted, as well as in the proposals to be included in each MPEM. In this context, a pragmatic objective-oriented approach was adopted, where municipalities were able to benefit from the support of a public higher education institution, namely the University of Minho.

This paper will present the main contents that supported the preparation of plans for the Municipal Electric Mobility of several municipalities that have joined the pilot phase of the Mobi.e. program, namely;

- "framework" which presents the recent path towards electric mobility in Portugal, synthesizing, in particular, the more relevant legislation framework;

- 'model of electric mobility' in its component parts, the value chain, actors, charging network and operation of the pilot phase;

- "Vision" strategy for electric mobility.

- "Charging network" which includes planning, design and location.

The components of the MPEM related with the preparation of the implementation plan, as well as the portfolio of incentive measures to be adopted by the municipalities for the promotion of electric mobility, and the two plans that are of great importance in the strategy of municipalities, namely the: communication plan and monitoring plan, which will not be presented here.

### **3 LEGAL FRAMEWORK FOR ELECTRIC MOBILITY**

The Portuguese strategy for Energy, approved by the government through the Resolution of the Council of Ministers nr.169/2005, sets the bases of the energy policy for the country. In order to improve the energy efficiency the National Action Plan for Energy Efficiency – “Portugal Efficiency 2015” was subsequently approved through the Resolution of the Council of Ministers nr. 80/2008 of 20<sup>th</sup> May.

In the implementation of this Plan it is intended that the country positions itself as a pioneer in adopting new models for mobility, environmentally sustainable and capable of exploring the relationship with the electric network and its integration with the cities.

Therefore, it is necessary to create conditions for the massification of the electric vehicle, ensuring an adequate infrastructure to the development of the electric vehicle fleet and the development of a service model that allows any citizen or organization to access any electric mobility solution supplied by any manufacturer of electric vehicles.

To achieve these goals, it is necessary to perform a complex work of preparation and implementation, which is based on the definition of concepts and models of service and business for the different stakeholders, in setting the appropriate legal and regulatory framework, as well as on the development of technical solutions for the charging points network and the management of the charging system.

Within this framework, the following items were approved by Resolution of the Council of Ministers nr. 20/2009 of 20<sup>th</sup> February 2 (PCM, 2009a):

1. Create the Program for Electric Mobility in Portugal, which aims at the introduction and mass use of the electric vehicle.
2. Determine that the Program for Electric Mobility in Portugal is headed by an office within the Ministry of Economy and Innovation, whose mission is embodied in the following key objectives:
  - a. Definition of the appropriate legal and regulatory framework for full implementation of the Program for Electric Mobility in Portugal;
  - b. Definition of the implementation model of the Program for Electric Mobility in Portugal, in its various components, including:
    - i. Definition of the model of service, business and implementation;
    - ii. Definition of the pilot network and its industrial components;
    - iii. Definition of management and coordination of the implementation of the Program for Electric Mobility in Portugal;
    - iv. Definition of forms of financing;
    - v. Development of the necessary technical solutions to implement a network and management system of charging points for electric vehicles
  - c. Definition of the work plan, activities and timelines, involved players and responsibilities;
  - d. Definition and implementation of the communication plan, directed to different players related with the supply and/ or demand, in Portugal and abroad and the promotion near to potential investors.

Through the Resolution of the Council of Ministers nr. 81/2009, the Portuguese Government decided to establish the strategic objectives of the Program for Electric Mobility, to define the fundamental underlying principles, to approve the electric mobility model, to establish the phases of the Program, to set measures to encourage the adoption of electric mobility and to promote the widespread use of the electric vehicle (PCM, 2009b).

For the strategic objectives of the Program for Electric Mobility, the following priorities were established:

- a) Accelerate the adoption of electric vehicles and allow the gradual conversion of the vehicle fleet;
- b) Encourage the creation of attractive conditions for investment, in Portugal, of manufacturing activities and the development of products related to the electric mobility, promoting Portuguese technologies and innovations;
- c) Ensure the contribution to fulfill the objectives of Kyoto's Protocol, by encouraging the use of renewable energy in mobility.

The fundamental principles underlying the program are:

- a) The model of electric mobility will be focused on the user, assuring equity and universality in the access to the charging network, regardless of the chosen energy supplier and ensuring the technical interoperability between different brands and models of vehicles, batteries and charging systems;
- b) The market for electric mobility should ensure attractive conditions for the entry of several companies in the market, in order to promote free competition;
- c) The use of renewable sources of energy will be emphasized, namely through the use of wind power capacity in periods of low consumption, benefiting from the mechanisms of decentralized production in urban areas, and anticipating the integration with electric smart grids in the logic of bidirectionality.

The program is developed along three phases, namely:

- a) The first phase - the 'Pilot Phase' - which is ongoing and will last until 2011, which includes the construction of a minimal experimental infrastructure for electric mobility at the national level, covering 25 municipalities and the country's major roads, which will allow testing the charging solutions;
- b) The second phase, called the "Growth Phase", which will start in 2012 and will involve the extension of the experimental infrastructure, with the adoption of solutions successfully tested in the previous phase, in particular in terms of the charging network;
- c) And a final "Consolidation Phase ", which begins as soon as the demand for electric vehicles reaches a sustained level, and simultaneously when the conditions for the introduction of a bidirectional charging system are created.

The principal measures to encourage the Program for Electric Mobility in the pilot phase and to promote the widespread use of the electric vehicles present the following critical aspects:

- a) Subsidies for the acquisition of electric cars by private users; the predicted value was of € 5000, which could reach € 6500 in the case of the substitution and destruction of an internal combustion vehicle, for the first 5000 electric cars, which should be finished by the end of 2012;
- b) Acquisition of 20% of electric vehicles in fleet renewal processes for the central government and the municipalities;

- c) Implementation of the experimental charging infrastructure, with the goal of the creation of 320 charging points in 2010 and 1350 in 2011;
- d) Implementation in Portugal of a platform for research, development and testing of the management systems of electric mobility.

Finally, the Decree-Law nr. 39/2010 of 26<sup>th</sup> April, regulated the organization, access and implementation of the activities related with electric mobility (MEID, 2010).

## **4 ELECTRIC MOBILITY MODEL**

### **4.1 Model components**

The Portuguese electric mobility model provides and integrates the following components:

- *Vehicles*: mobility component that must have capacity to interact with the electricity network;
- *Batteries*: components that store electrical energy, and allow the operation of vehicles;
- *Charging points*: infrastructure that enables the interface between vehicles and the electricity network in order to charge their batteries;
- *Supplier of electricity for electric mobility*: the agent legally authorized to do so;
- *Services*: (beyond the basic charging service) - association of potential services, such as parking, financing solutions, leasing of vehicles and batteries;
- *Management system*: responsible for the management of the various flows (information, energy and financial) associated with the charging of vehicles, ensuring technological compatibility among the various infrastructure and services of electric mobility and ensuring a national charging network accessible to any user of electric vehicles.

### **4.2 Chain of Value**

The chain of value associated with electric mobility encompasses the following types of activities that correspond to services, such as:

- a) Installation and maintenance of the network, which includes normal (designated as slow) and fast charging points;
- b) Charging service - related to the provision of electricity for electric mobility, as well as the operation of the necessary infrastructure;
- c) Commerce of electricity, which corresponds to wholesale purchase and to retail sale of electric power to the users of electric vehicles for the purpose of charging their batteries in charging points in the integrated network of electric mobility;
- d) Provision of other services associated with the electric mobility (parking, financing solutions, leasing of vehicles and batteries, among others).

### **4.3 Players**

The model includes the following typology of players in the market for electric mobility:

- a) Operators of charging points: responsible for the installation, provision, operation and maintenance of the charging points for public or private access, integrated on the electric mobility network;
- b) Retailers of electricity for electric mobility: responsible for wholesale purchase and retail sale of electricity to supply to the electric vehicle, with the purpose of charging their batteries in charging points in the integrated electric mobility network.
- c) Manager of operations of the electric mobility network: manages the various flows (information, energy and financial) associated with the charging of vehicles, ensuring technological compatibility between the various infrastructures and services of electric mobility and ensuring a national charging network accessible to any user of electric vehicles.

#### **4.4 Charging network**

The main features of the national network of charging for electric mobility are the following:

##### **Type**

The charging infrastructure for electric vehicle includes the following typologies of spaces in terms of accessibility:

- *Public spaces of public access*: considered the charging points available in the street and in public car parks explored, or not, by private entities;
- *Private spaces of public access*: places that are private and have public access, in particular private car parks, shopping centers and service areas;
- *Private spaces of private access*: correspond to parking in households (condominiums or private) and garages of companies.

##### **Type of charging**

In the charging types to be made available, are included:

- *Normal charging points* - usually located in public spaces, such as roads and public or private parking areas with public access, other than those located in households and companies, allowing to fully charge a battery typically in about eight hours;
- *Fast charging points* - usually located at service stations along major highways and other strategic locations that allow charging in about twenty to thirty minutes.

#### **Phases of Electric Mobility Program**

It is expected that the Program has three phases, namely:

##### **- Pilot phase**

The pilot charging network has an experimental goal and seeks to validate technological solutions, of service and business, to attract manufacturers to test vehicles, different engines, forms of storage and charging. At this stage, there are

privileged normal charging solutions, which ensure the access to multiple commerce/ suppliers of electricity for electric mobility.

#### - Growth and consolidation phase

After the validation of the solutions and models, the growth and consolidation phase will seek to meet the various demands of the market, extending the territorial coverage of the network and progressively integrating bidirectional trends associated with intelligent electric smart grids.

In these phases, it is assumed that the infrastructure will be capable of integrating the various components, allowing the existence of an integrated network of charging infrastructures at a national level.

With the emergence of smart grids and bidirectional charging technologies, it is expected that in public and private spaces these options are adopted, thus enabling not only the purchase but also the sale of electricity stored in batteries of electric vehicles.

### **4.5 Operation of the pilot phase**

The pilot network will be implemented between 2010 and 2012 and covers the installation of at least 1350 normal charging points and 50 fast charging points.

The normal charging points will be installed on a network of 25 municipalities, which for this purpose signed an agreement with the Portuguese Government in 2009.

The 25 municipalities presented in Fig. 1 of the pilot charging network are: Almada, Aveiro, Beja, Braga, Bragança, Cascais, Castelo Branco, Coimbra, Évora, Faro, Guarda, Guimarães, Leiria, Lisboa, Loures, Portalegre, Porto, Santarém, Setúbal, Sintra, Torres Vedras, Viana do Castelo, Vila Nova de Gaia, Vila Real e Viseu.

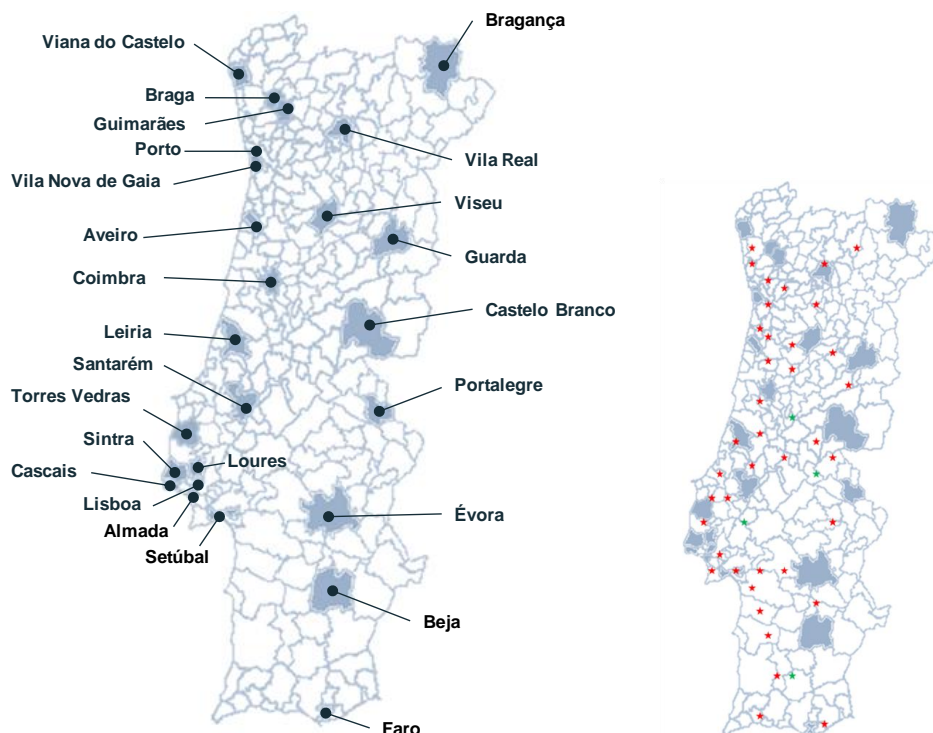


Fig.1 Widespread pilot charging network (red points represent the fast charging locations)



The fast charging points will be available along the main roads, with particular emphasis on the A1 (Lisbon-Porto) and A2 (Lisbon – Algarve) motorways and in another specific locations.

The planning and execution of experimental infrastructure of electric mobility, expected in the Pilot Phase, require the development of Municipal Plans for Electric Mobility (MPEM).

The overall objective of the MPEM is to create conditions for the implementation of a network of charging points, as well as to accelerate the adoption of electric vehicle, by creating attractive conditions for their use and promotion and by demonstrating and disseminating the benefits of its use and adoption.

It should be noted that the MPEM is not a conventional mobility plan. It is, rather, a plan for the promotion and incentive of electric mobility and it must necessarily be related with the plans and mobility practices in the municipality.

## **5 VISION**

The vision underlying the National Program for Electric Mobility is the positioning of Portugal as a pioneer country in the adoption of new models for electric mobility that are sustainable from an environmental point of view and that are capable of optimizing the rational use of electricity, taking advantage of the energy produced from renewable sources.

At the level of the municipalities, the cities aspire to be, and to be recognized as, more sustainable urban areas, less noisy and polluted, where individuals, families and businesses benefit from a lower mobility bill that arises from the possibility of adopting the electric alternative.

The stated vision is consistent with the established national policies, namely the: National Energy Strategy and National Action Plan for Energy Efficiency (PNAEE), National Plan for Climate Change (PNAC), National Strategy for Sustainable Development (ENSD); National Policy Planning (PNPOT) and the Strategic Plan for Transports (PET).

## **6 CHARGING NETWORK**

### **6.1 Design and location of charging points**

The charging network of batteries of electric vehicles will be, perhaps, the most visible element of the Municipal Plan for Electric Mobility. Its design is still, at present, an exploratory exercise, since there are no historical data, there is not set any consensual profile of the potential users of electric vehicles, there are no accurate projections about the availability of electric vehicles and, finally, the rhythm of development of the battery technology is unknown. It is this framework that makes the project an experimental exercise.

A careful analysis of international experiences, both in Europe and the United States of America, reveals that there is a lack of theoretical support for dimensioning charging networks for electric vehicles. The existing initiatives systematically take an experimental or pilot phase with the main objective of creating conditions to attract users to this new form of mobility, thus improving the adoption curve of electric vehicles. It is estimated that this scenario will remain until about 2015, and subsequently it might be possible to develop design and projection models based on demand-supply approaches.

Therefore, an international pilot initiative was selected, from which ratios coverage for charging points could be adopted, with the necessary adaptations, particularly taking into account the national rates of motorization.

The expected charging pilot network for Portugal has the particularity of covering the entire country, through the implementation of 25 local networks, which distinguishes it from most European international initiatives that focus on a single city like the Delivery Plan for Electric Vehicles in London (Mayor of London, 2009). For this reason a multi-city approach was chosen as a reference, having been identified the *EV Project* of the ECOTality in the USA.

The EV Project is one of the most comprehensive initiatives known to provide a charging network and to study the topic of electric mobility (ETEC, 2010). It was created in August 2009 with a budget of over 200 million dollars, having received funding from the U.S. federal government (U.S. Department of Energy) of about 100 million. Under this project charging points in public and private houses will be installed in 11 cities of 5 states: Arizona (Phoenix and Tucson), Washington (Seattle), Oregon (Portland, Salem, Corvallis and Eugene), California (San Diego) and Tennessee (Nashville, Chattanooga and Knoxville).

One of the partners of the *EV Project* is Nissan, which will provide 4700 Nissan Leaf electric cars. With the permission of the respective owners, the project leaders will gather and analyze data to evaluate the efficiency of the new charging infrastructure. The collection phase will take two years, after which will follow about an year of analysis and conclusions in a way that by the end of 2013 it should be possible to define the terms and strategy for the launch of electric mobility at a national level in the U.S.

The EV Project included the installation of:

- 4700 Level 2 charging points (slow charging at 220V, PCL) in households;
- 6250 Level 2 charging points (PCL) in public access locations;
- 260 Level 3 charging points (fast charging, PCR).

For the determination of the ratios for the pilot project, the residential points are not considered. Thus, the calculated ratio is about 1.15 PCL/1000 inhabitants, from which derives a relationship of 1 PCR for each 24 PCL.

For the Portuguese case, the design of the pilot charging network was made for the year 2015. Thus, a projection was made of the population for each of the 25 municipalities of the national network for 2015, in which the coverage ratio calculated above was applied, adjusted according to the differences in the motorization rate.

The pilot phase of the national network, which runs between 2010 and 2012, is called Mobi.E network and was coordinated by the Office for Electric Mobility (GAMEP). Under the scope of the program of electric mobility, GAMEP defined the total number of PCL, which will thus be the first of the total projected points for 2015.

Given the pilot nature of the Mobi.E network, demand-supply logic is not yet central. The same applies for the location of the charging areas.

An indicative set of common principles was defined for the location of the charging points, in order to give consistency, cohesion and homogeneity to the network. The methodology adopted two levels of location:

- Macro level, which purpose is to allocate the number of charging points (2012 and 2015 horizons) within the municipal area, considering zones/ neighborhoods/ districts/ agglomerates. At this level, were considered criteria such as: political and strategic interest, road infrastructure and dynamics of circulation and parking; traffic generators, presence of central local areas associated with equipments, services or businesses.
- Micro level, where the objective is the specific location of the charging areas of the pilot phase (until 2012) within the zones/ districts/ agglomerates. At this level, the following priorities were considered: main central streets, parking areas with public access, residential areas where private parking is scarce, commercial areas, services and leisure, business areas, taxi waiting areas (fast charging); possibility (in terms of physical space - area and volume) to associate other facilities to the charging areas, such as the installation of renewable energy micro-generation and advertising.

## **7 CONCLUSIONS**

In this paper were presented the main contents that supported the preparation of the Municipal Plans for Electric Mobility of 25 municipalities that have joined the pilot phase of the Mobi.E program, mainly in terms of: the most relevant legislation that underlies the electric mobility in Portugal; the presentation of the main components of the model of electric mobility, namely the chain of value, players, the design of the charging network and the operation of the pilot phase. The common strategy for electric mobility in Portugal was detailed, through the definition of a vision that is transverse to all the involved municipalities and the key aspects that were accomplished at a micro and macro level on planning, design and on the definition of the charging point location in each municipality.

This paper also represents the beginning of the involvement of local municipalities through the definition of the main theoretical background that supported the execution of all Municipal Plans for Electric Mobility during the Pilot phase of Mobi.E program.

Electric mobility could represent the ultimate change on the paradigm of nowadays mobility, because through the investment in new energy models for mobility that aim to improve the quality of life in cities, Portugal can have a reduction in the growing

dependence on oil for energy and in the huge environmental impact of the use of fossil fuels and thus achieve more sustainable mobility patterns.

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MOBI.E: <https://www.mobie.pt/en/>

EV Project: <http://www.theevproject.com/>